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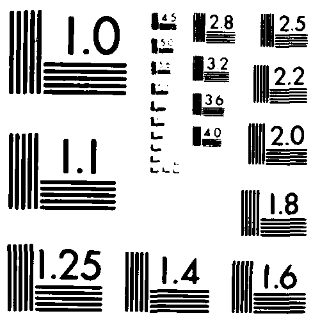

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LEVEL II (2)

AWS/TR-79/005

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FORECASTING ALTIMETER SETTINGS

December 1979

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AIR WEATHER SERVICE (MAC)
Scott AFB, Illinois 62225

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John W. Louer III

JOHN W. LOUER, III
Chief, Editorial Section, USAFETAC

FOR THE COMMANDER

Walter S. Burgmann

WALTER S. BURGMANN
Scientific and Technical Information
Officer (STINFO)

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER AWS/TR-79/005	2. GOVT ACCESSION NO. AD-A098	3. RECIPIENT'S CATALOG NUMBER 599
4. TITLE (and Subtitle) Forecasting Altimeter Settings		5. TYPE OF REPORT & PERIOD COVERED Technical Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s)		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Hq Air Weather Service/DNT Scott AFB, Illinois 62225		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Hq Air Weather Service/DNT Scott AFB, Illinois 62225		12. REPORT DATE December 1979
		13. NUMBER OF PAGES 39
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

This Technical Report is a redesignation of AWSM 105-54, Forecasting Altimeter Settings, 1 September 1960. No changes have been made to the original text.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Forecasting
Altimeter settings

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report discusses four methods for converting a forecast sea-level pressure to a forecast altimeter setting. The first method, which is the shortest and the easiest to use, gives acceptable accuracy at most stations below 1000 feet elevation and at many stations above 1000 feet. The second method is more general and is designed primarily for use at stations above 1000 feet in cases when large pressure and/or temperature changes are expected during the forecast period. Both the first and second methods require concurrent (Continued)

20. ABSTRACT: Continued

values of sea-level pressure and altimeter setting at the forecast station. The third method is useful when concurrent values of sea-level pressure and altimeter setting are not available. It may be used at any elevation. The fourth method enables the forecaster to convert a forecast altimeter setting at one station to a forecast altimeter setting at a nearby station. Step-by-step procedures are outlined for each method, and the necessary nomograms and a table (Appendix A) are included. A theoretical discussion of the basis for the methods is presented in Appendix B.

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Chapter 1

INTRODUCTION

1. General.

At most weather stations, both sea-level pressure and altimeter setting are derived from station pressure by use of special tables prepared for the particular station. There is no one, simple, accurate method which can be used in all cases to convert sea-level pressure directly to altimeter setting. Because routine prognostic charts are not prepared for either station pressure or altimeter setting, the forecaster is frequently faced with the problem of converting sea-level pressure (which is provided by the prognostic charts usually available) to altimeter setting. This manual presents methods for making this conversion which are practical for routine use, and yet give results of acceptable accuracy.

2. Forecasts of Sea-Level Pressure.

This manual is not concerned with the method(s) used in arriving at the sea-level pressure forecasts which are the basis for forecasting altimeter settings. It is assumed that these sea-level pressure forecasts will be made by use of meteorologically sound procedures.

3. Discussion of Methods.

Four methods for making altimeter-setting forecasts are presented in detail in Chapter 2. They are described briefly below to facilitate comparisons.

a. Method I should be used in the majority of cases, especially at stations below 1000-feet elevation. It may also be used for locations above 1000 feet, provided significant changes in temperature, pressure, and moisture are not expected to occur during the forecast period (see paragraph 5a for the magnitude of "significant" changes). Method I requires as input data: a forecast sea-level pressure, and the current difference between the altimeter setting and the sea-level pressure at the forecast station.

b. Method II is an expanded version of Method I and should be used for stations above 1000-feet elevation whenever significant temperature, pressure, or moisture changes are expected to occur during the forecast period. (Note that "significant" changes may be smaller at high elevations than at low elevations — see paragraph 5a). Method II can also be used for stations below 1000 feet, but the increase in accuracy of results over Method I normally is not sufficient to justify the additional time and labor required in the computations. Method II requires as input data the following information for the forecast location: a forecast sea-level pressure, the current difference between altimeter setting and sea-level pressure, the current temperature and dew point, the temperature 12 hours prior to the current time, a forecast temperature at the valid time of the altimeter-setting forecast, and the temperature 12 hours prior to that time.

c. Method III may be used when the forecaster does not have current observed values of altimeter setting and sea-level pressure at the station for which the forecast is being made. Method III requires as input data the following information for the forecast location: forecast values of sea-level pressure, temperature and dew point at the valid time of altimeter-setting forecast, and the temperature 12 hours prior to that time.

d. Method IV uses the difference between forecast sea-level pressure and forecast altimeter setting at one station to arrive

at a forecast altimeter setting at a nearby station. This method may be useful in cases when the forecast sea-level pressure and forecast altimeter setting for one station are already available, and a forecast altimeter setting for a nearby station is desired. Refer to paragraph 8 for the input data required in Method IV.

e. These four methods have not been tested exhaustively. However, they have been tested on enough observed cases to insure their soundness. The root-mean-square error of each of the methods was less than 0.03 inches of mercury (less than 30 feet of altitude). The largest error found in 210 test cases was 0.04 inches of mercury (about 40 feet of altitude). These errors are less than those normally encountered in forecasts of sea-level pressure. (Note that Method I was tested only for stations below 1000 feet MSL, and that the highest station used in the tests of Method II was at an elevation of 6170 feet MSL.)

f. At first glance, all four methods appear rather complicated. However, the individual steps in the procedures are very simple. Also, with experience, forecasters will soon learn when various short cuts can be used safely.

g. There are, of course, other methods for converting sea-level pressure to altimeter setting. However, for any method to be accurate for stations above 1000 feet MSL, it must:

(1) Take into account the effects of temperature and pressure changes during the forecast period on the difference between sea-level pressure and altimeter setting.

(2) Use a moisture correction when the surface mixing ratio is high.

(3) Take into account the plateau correction and lapse-rate anomaly for stations in the United States and Alaska.

h. One method which should not be used has come to the attention of Hq AWS. This method is based on interpolation between pairs of standard constant-pressure-surface heights, above and below station level. In a test of some 200 cases using appropriate pairs of observed 1000-, 850-, and 700-mb data, errors were frequently more than 0.30 inches of mercury (about 300 feet of altitude error), and the largest error was 0.69 inches of mercury (about 700 feet of altitude).

i. It would be possible to forecast altimeter setting directly. However, this would require synoptic charts of altimeter setting (as proposed by Bellamy), and is not considered practical for routine use.

Chapter 2

SPECIFIC PROCEDURES

4. General.

Four methods for computing forecast altimeter settings are outlined in detail below. Each method is treated in a separate paragraph, using an operational, step-by-step format. Theoretical discussions of these methods are given in Appendix B. Local reproduction of the nomograms in Figures 1-14 is authorized.

5. Method I.

This method should be used in the great majority of cases, especially for locations below 1000-feet elevation. It is based on the forecast sea-level pressure and the current, or latest available, difference between the altimeter setting and the sea-level pressure at the station in question.

a. The difference ($\triangle P$) between altimeter setting and sea-level pressure changes with both temperature and pressure. However, this change can be neglected if it is less than 1 mb. This will nearly always be the case for stations at or below 1000 feet above MSL, and will generally be true for higher stations except when there is a strong frontal passage during the forecast period. The magnitude of the change in $\triangle P$ can be estimated by a preliminary check of Figures 6 and 7 (see Steps 14, 15, and 17 through 19, paragraph 6b, for the procedures). If the change of $\triangle P$ appears likely to be more than 1 mb, use Method II, as outlined in paragraph 6.

b. To forecast the altimeter setting by Method I:

Step 1. Obtain the latest available corresponding values of sea-level pressure (P_{SL}) and altimeter setting (P_{AS}) for the station in question.

Step 2. Convert P_{AS} to millibars by use of Figure 1, interpolating to the nearest 0.2 mb.

Step 3. Compute $\triangle P$, using the formula:

$$\triangle P = P_{AS} - P_{SL}$$

Step 4. Obtain a forecast sea-level pressure (P_{SLF}) in millibars for the station for the desired valid time.

Step 5. Using P_{SLF} from Step 4, compute the forecast altieter setting (P_{ASF}) in millibars by the formula:

$$P_{ASF} = P_{SLF} + \triangle P$$

Step 6. Convert P_{ASF} to inches of mercury, interpolating to the nearest 0.02 inch, by the use of Figure 1. This is the desired forecast altimeter setting.

6. Method II:

a. If the difference ($\triangle P$) between altimeter setting and sea-level pressure is expected to change by more than 1 mb during the forecast period (in general, this will occur only at stations above 1000-feet elevation), then this method must be used, rather than Method I.

b. The steps in the procedure are as follows:

Step 1. Obtain the latest available corresponding values of sea-level pressure (P_{SL}), altimeter setting (P_{AS}), station temperature (T), dew point (T_d), and station temperature 12 hours previous (T_{-12}) in °F.

Step 2. Convert P_{AS} to millibars by use of Figure 1, *interpolating* to the nearest 0.2 mb.

Step 3. Compute $\triangle P$, using the formula:

$$\triangle P = P_{AS} - P_{SL}$$

Step 4. Obtain a forecast sea-level pressure (P_{SLF}) in millibars for the station for the desired valid time.

Step 5. Find the station elevation, and the annual normal station temperature (T_{sn}) in °F, which are given for most U.S. stations in Appendix A. If the station is not listed in Appendix A, find its elevation from the Enroute Supplement, USAF Flight Information Publication, or some other data source, and interpolate its annual normal station temperature from nearby stations of similar elevation listed in Appendix A.

Step 6. Compute the 12-hour-mean station temperature (T_s) to the nearest whole degree by the formula:

$$T_s = \frac{T + T_{-12}}{2}$$

Step 7. Enter Figure 5 with T_d and the station elevation to find the approximate moisture correction ($e_s C_h$) to the nearest whole degree.

Step 8. Enter Figure 4 with the station elevation and ($T_s - T_{sn}$) to find the F factor, which is the combined plateau and lapse-rate-anomaly correction, to the nearest whole degree.

Step 9. Compute the initial adjusted mean temperature (T_m) to the nearest whole degree using the formula:

$$T_m = T_s + e_s C_h + F$$

Step 10. Obtain forecasts of T_s and T_d for the desired valid time of altimeter-setting forecast, and repeat Steps 7 and 8 using these forecast values.

Step 11. Repeat Step 9 using the results of Step 10. This gives a forecast value of T_m.

Step 12. Compute $\triangle T_m$, which is the change in T_m during the forecast period, by the formula:

$$\triangle T_m = T_{m\ \mathrm{forecast}} - T_{m\ \mathrm{initial}}$$

Step 13. Compute $T_{m\ \mathrm{mean}}$, the time-average of the two T_m's, by the formula:

$$T_{m\ \mathrm{mean}} = \frac{T_{m\ \mathrm{forecast}} + T_{m\ \mathrm{initial}}}{2}$$

Step 14. Enter Figure 6 with station elevation and $T_{m\,mean}$ to find ΔP_T, which is the change of ΔP with a 1 °F increase of T_m. Read ΔP_T to the nearest 0.02 mb.

Step 15. Multiply ΔP_T from Step 14 by ΔT_m from Step 12 to find $\Delta(\Delta P)_T$, which is the change in ΔP due to the forecast change in T_m. The equation is:

$$\Delta(\Delta P)_T = (\Delta T_m) \times (\Delta P_T)$$

Be sure to carry the minus sign if ΔT_m is negative.

Step 16. Compute the expected change in sea-level pressure (ΔP_{SL}) by the formula:

$$\Delta P_{SL} = P_{SLF} - P_{SL}$$

Step 17. Enter Figure 7 with station elevation and $T_{m\,mean}$ to obtain ΔP_p, which is the change in ΔP with a 1-mb increase of P_{SL}. Read ΔP_p to the nearest 0.01 mb. Note that ΔP_p is always negative for stations above MSL.

Step 18. Multiply ΔP_{SL} by ΔP_p to obtain $\Delta(\Delta P)_p$, which is the change in ΔP due to the forecast change in sea-level pressure. The equation is:

$$\Delta(\Delta P)_p = (\Delta P_{SL}) \times (\Delta P_p)$$

Be sure to retain the appropriate algebraic signs.

Step 19. Compute $\Delta(\Delta P)$, which is the total change in ΔP expected during the forecast period, from the sum of these two component changes, by the formula:

$$\Delta(\Delta P) = \Delta(\Delta P)_T + \Delta(\Delta P)_p$$

Step 20. Compute $\Delta P_{forecast}$, which is the difference between the altimeter setting and sea-level pressure at the forecast time from the equation:

$$\Delta P_{forecast} = \Delta P_{initial} + \Delta(\Delta P)$$

Step 21. Compute the forecast altimeter setting to the nearest millibar, by the formula:

$$P_{ASF} = P_{SLF} + \Delta P_{forecast}$$

Step 22. Convert the forecast altimeter setting from Step 21 to inches of mercury to the nearest 0.02 inch by use of Figure 1. This is the desired forecast altimeter setting.

7. Method III:

a. This method is to be used in cases where concurrent values of sea-level pressure (P_{SL}) and altimeter setting (P_{AS}) are not available to the forecaster. The method is derived from generalized procedures used in obtaining sea-level pressure and altimeter setting from station pressure (refer to Appendix B for further details).

b. To use Method III:

Step 1. Look up the station elevation, and the annual normal station temperature (T_{sn}) in Appendix A. If the station is not listed in Appendix A, find its elevation from the <u>Enroute Supplement, USAF Flight Information Publication</u>, or some other data source, and

interpolate its annual normal station temperature from nearby stations of similar elevation listed in Appendix A.

Step 2. Secure forecast values of sea-level pressure (P_{SLF}), station temperature (T), and dew point (T_d), valid at the expected landing time.

Step 3. Secure a value of station temperature valid 12 hours before the expected landing time (T_{-12}).

Step 4. Compute the 12-hour mean station temperature (T_s) to the nearest whole degree, by the formula:

$$T_s = \frac{T + T_{-12}}{2}$$

Step 5. If the station elevation is 1000 feet or less, enter Figure 2 or Figure 3, as appropriate, with the annual normal station temperature (T_{sn}) and the value of T_s from Step 4 to determine the F factor to the nearest whole degree.

Step 6. If the station elevation is more than 1000 feet, enter Figure 4 with the station elevation and the quantity (T_s - T_{sn}) to determine the F factor to the nearest whole degree.

Step 7. Enter Figure 5 with the station elevation and the dew point (T_d) to determine the approximate moisture correction ($e_s C_h$) to the nearest whole degree.

Step 8. Compute the adjusted mean temperature (T_m) from the formula:

$$T_m = T_s + e_s C_h + F$$

Step 9. Enter Figure 9, 11, or 13 (depending on the station elevation) with T_m from Step 8 and the station elevation to determine ΔP_1, which is one component of ΔP. Read ΔP_1, to the nearest 0.5 mb if station is below 6000 feet MSL, and to the nearest whole millibar if above 6000 feet MSL.

Step 10. Enter Figure 10, 12, or 14 (depending on the station elevation) with the station elevation, T_m from Step 8, and P_{SLF} from Step 2 to determine ΔP_2, which is another component of ΔP. Read ΔP_2 to the nearest 0.5 mb if station is below 6000 feet MSL, and to the nearest whole millibar if above 6000 feet MSL.

Step 11. Compute ΔP, which is the difference between altimeter setting and sea-level pressure, from the equation:

$$\Delta P = \Delta P_1 + \Delta P_2$$

Be sure to retain the proper algebraic signs.

Step 12. Compute the forecast altimeter setting (P_{ASF}) to the nearest 0.5 mb, using the formula:

$$P_{ASF} = P_{SLF} + \Delta P$$

Step 13. Convert P_{ASF} from Step 12 to inches of mercury, to the nearest 0.02 inch, by the use of Figure 1. This is the desired forecast altimeter setting.

8. Method IV:

a. This method may be used when a forecast altimeter setting is available for a station near the one for which a forecast altimeter setting is desired. Its accuracy is an irregular function of the horizontal and vertical separation between the two stations. The horizontal separation is important only in that it affects the difference between the adjusted 12-hour mean temperatures (T_m's) of the two stations; the T_m's should not be more than 10°F different. The vertical separation should not be more than 1000 feet. If either of these limitations is exceeded, then one of the other methods, I, II, or III, should be used.

b. To use Method IV:

Step 1. Obtain a forecast altimeter setting (P_{ASF}), valid at the expected landing time, for a station as near as possible to the desired station.

Step 2. Find the station elevation (H) and the annual normal station temperature (T_{sn}) for each station from Appendix A. If the station is not listed in Appendix A, find its elevation from the Enroute Supplement, USAF Flight Information Publication, or some other data source, and interpolate its annual normal station temperature from nearby stations of similar elevation listed in Appendix A. Call the lower station "Station 1," and the higher, "Station 2."

Step 3. Obtain forecasts of sea-level pressure (P_{SLF}), station temperature (T), and dew point (T_d) for each of the two stations at the expected landing time.

Step 4. Obtain a forecast of station temperature for each station valid 12 hours previous to the expected landing time (T_{-12}).

Step 5. Compute the 12-hour mean temperature (T_s) for each station, to the nearest whole degree, from the formula:

$$T_s = \frac{T + T_{-12}}{2}$$

Step 6. Enter Figure 5 with T_d and the station elevation to determine the approximate moisture correction ($e_s C_h$), to the nearest degree, for each station.

Step 7. Determine the F factor for each station to the nearest whole degree.

(a) For station elevations less than 1000 feet, enter Figure 2 or Figure 3, as appropriate, with the annual normal station temperature (T_{sn}) and the value of T_s from Step 5 to determine the F factor.

(b) For elevations greater than 1000 feet, enter Figure 4 with the station elevation and the quantity (T_s - T_{sn}) to determine the F factor.

Step 8. Compute for each station the adjusted mean temperature (T_m), to the nearest whole degree, using the formula:

$$T_m = T_s + e_s C_h + F$$

Step 9. Compute T_a, the average of the two T_m's, from the equation:

$$T_a = \frac{T_{m1} + T_{m2}}{2}$$

(The number subscripts refer to the two stations as specified in Step 2.)

Step 10. Find the difference in forecast sea-level pressures ($\triangle P_d$) between the two stations by use of the formula:

$$\triangle P_d = P_{SLF\ 1} - P_{SLF\ 2}$$

Remember that Station 2 is at the higher elevation; and also be sure to carry the proper algebraic sign of P_d in the remaining computations.

Step 11. Convert P_d to inches of mercury, to the nearest 0.02 inch, by use of the lowest scale in Figure 1.

Step 12. Enter Figure 8 with H_1, T_a from Step 9, and the quantity (H_2 - H_1) to determine P_H, which is the difference in altimeter settings due to differences in elevation and temperature. Read P_H to the nearest 0.02 inch.

Step 13. Compute the difference in altimeter settings between the two stations (P_{AS}) from the equation:

$$P_{AS} = P_d + P_H$$

Step 14 Finally, compute the desired forecast altimeter setting from either

$$P_{ASF\ 1} = P_{ASF\ 2} + P_{AS}$$

or

$$P_{ASF\ 2} = P_{ASF\ 1} - P_{AS}$$

depending on whether the station in question is at a lower or a higher elevation than the station for which the forecast altimeter setting was available.

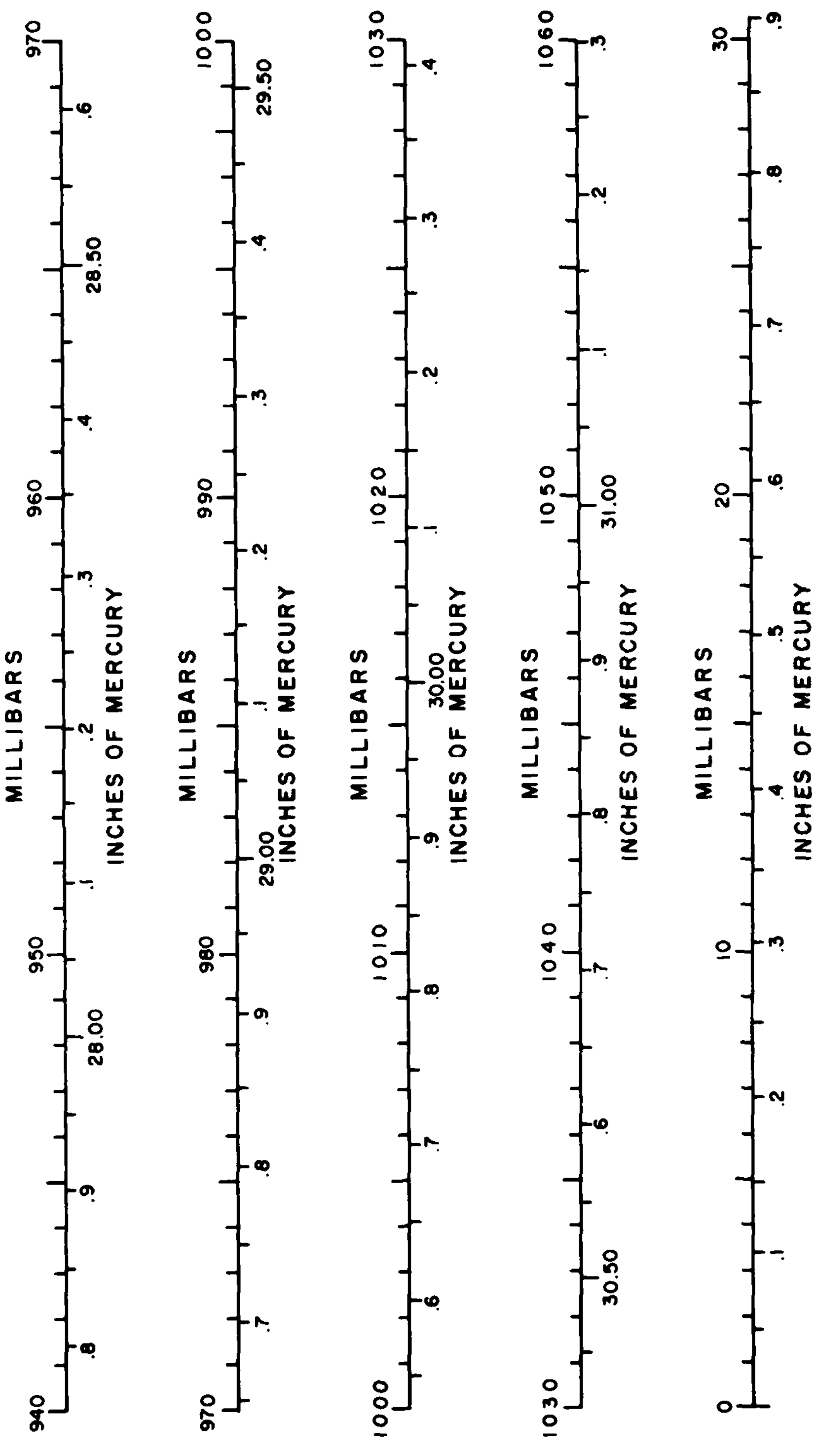

Figure 1. Conversion Scales — Millibars to Inches of Mercury.

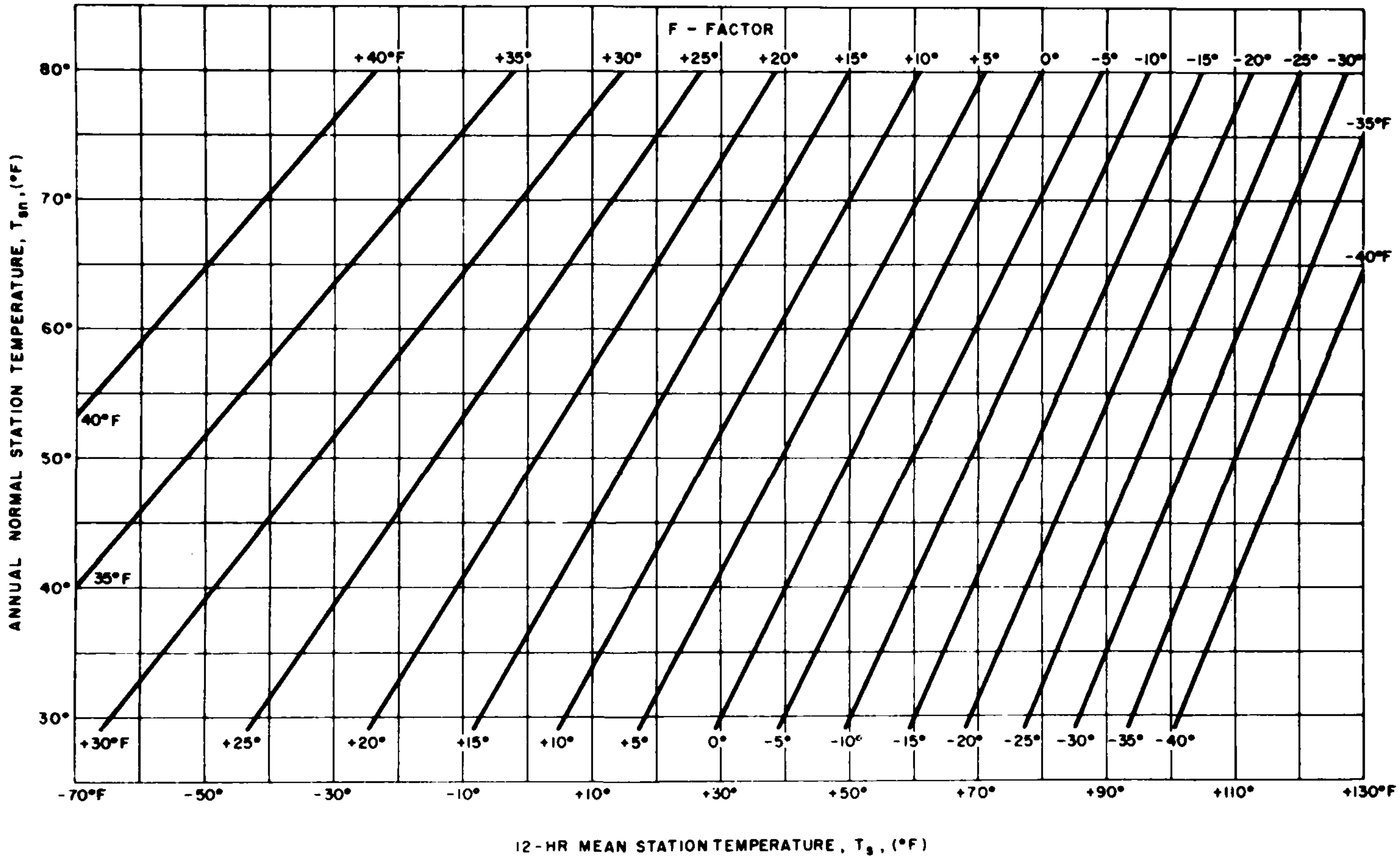

Figure 2. Nomogram for Determining the F Factor for Stations in the Continental United States (excluding Alaska) Having Elevations of 1000 Feet or Less. The F factor is the combined plateau and lapse-rate anomaly correction. The required input data are the 12-hour mean temperature, T_s, and the annual normal station temperature, T_{sn}. Read F to the nearest whole degree.

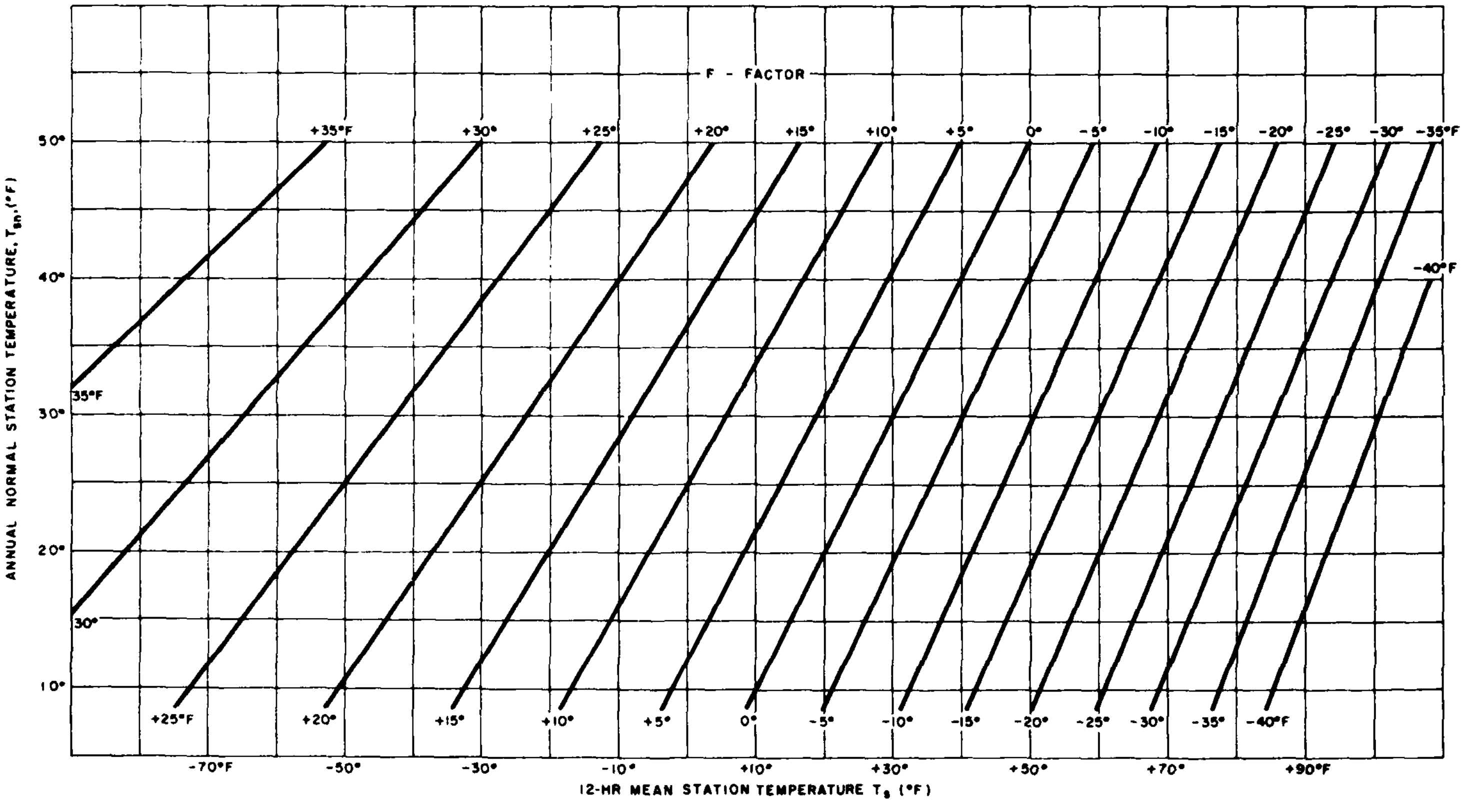

Figure 3. Nomogram for Determining the *F* Factor for Alaskan Stations Having Elevations of 1000 Feet or Less. The *F* factor is the combined plateau and lapse-rate anomaly correction. The required input data are the 12-hour mean temperature, T_s, and the annual normal station temperature T_{sn}. Read *F* to the nearest whole degree.

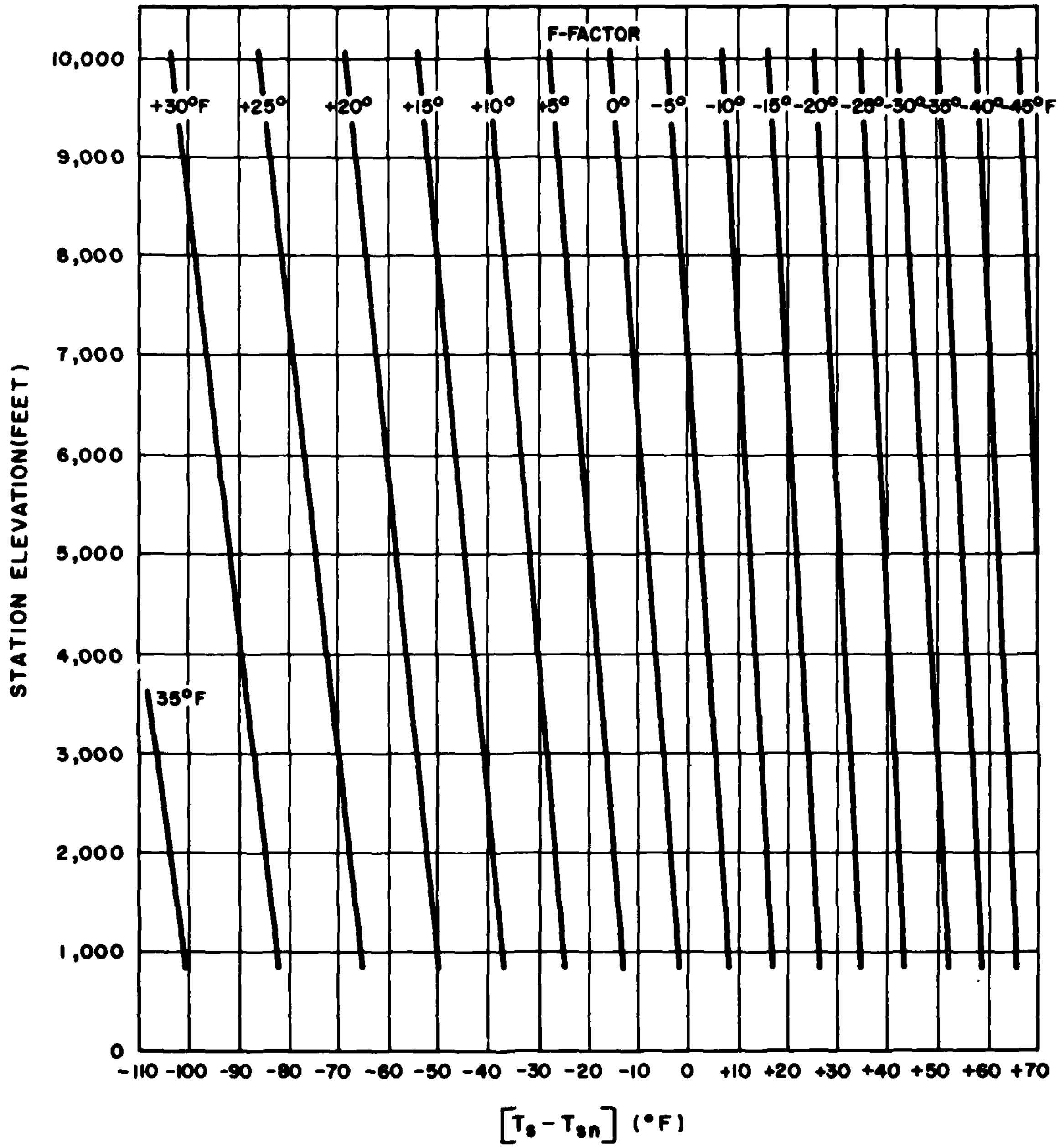

Figure 4. Nomogram for Determining the F Factor for Stations in Both the Continental United States and Alaska Having Elevations Greater than 1000 Feet. The F factor is the combined plateau and lapse-rate anomaly correction. The required input data are the station elevation, and the difference between the 12-hour-mean temperature and the annual normal station temperature (T_s - T_{sn}). Read F to the nearest whole degree.

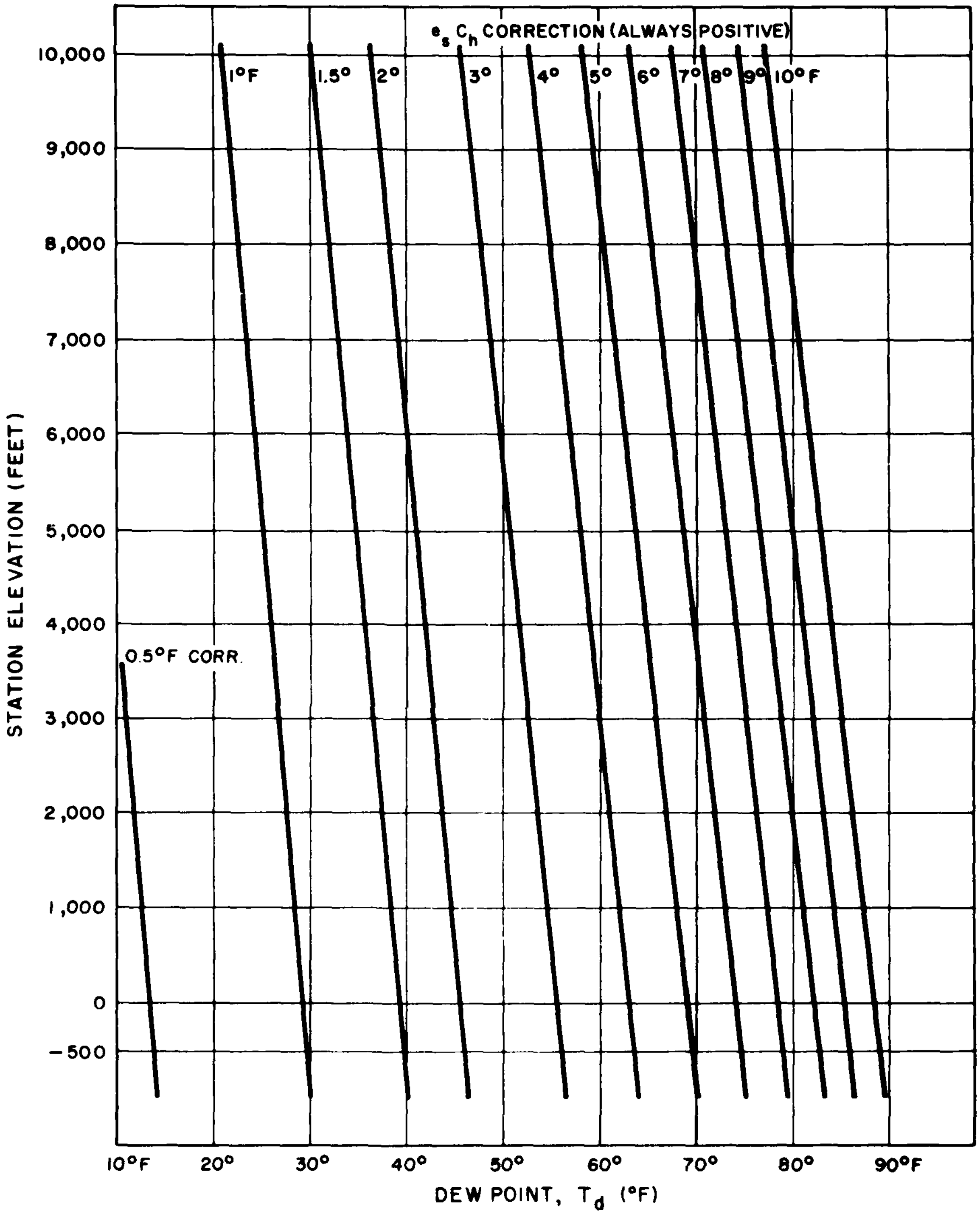

Figure 5. Nomogram for Determining $e_s C_h$, the Approximate Moisture Correction. The required input data are station elevation, and the dew point, T_d. Read $e_s C_h$ to the nearest whole degree.

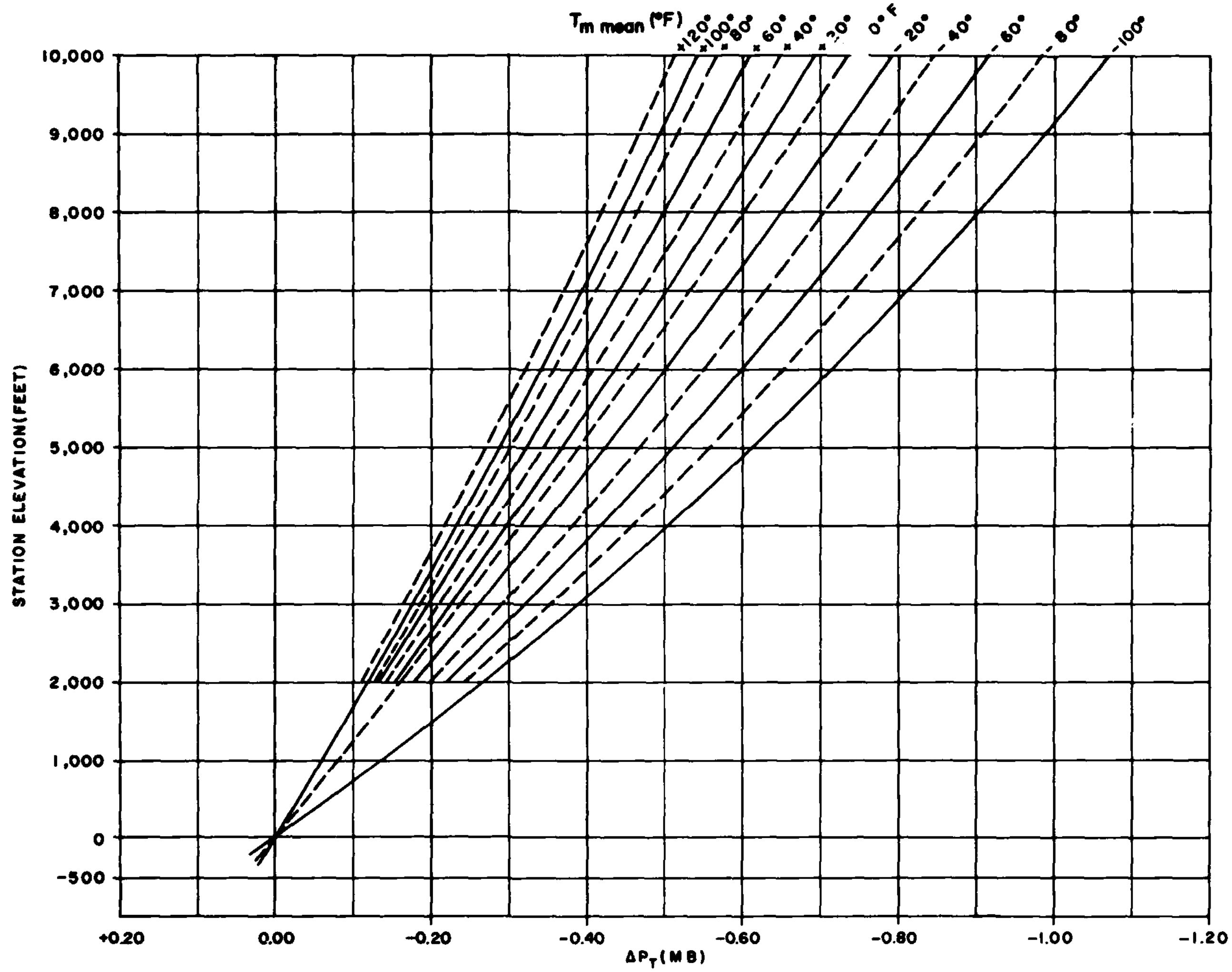

Figure 6. Nomogram for Determining ΔP_T, Which Is the Change of ΔP Produced by a 1°F Increase of T_m. The required input data are the station elevation, and the adjusted mean temperature, $T_{m\ mean}$. Read ΔP_T to the nearest 0.02 mb.

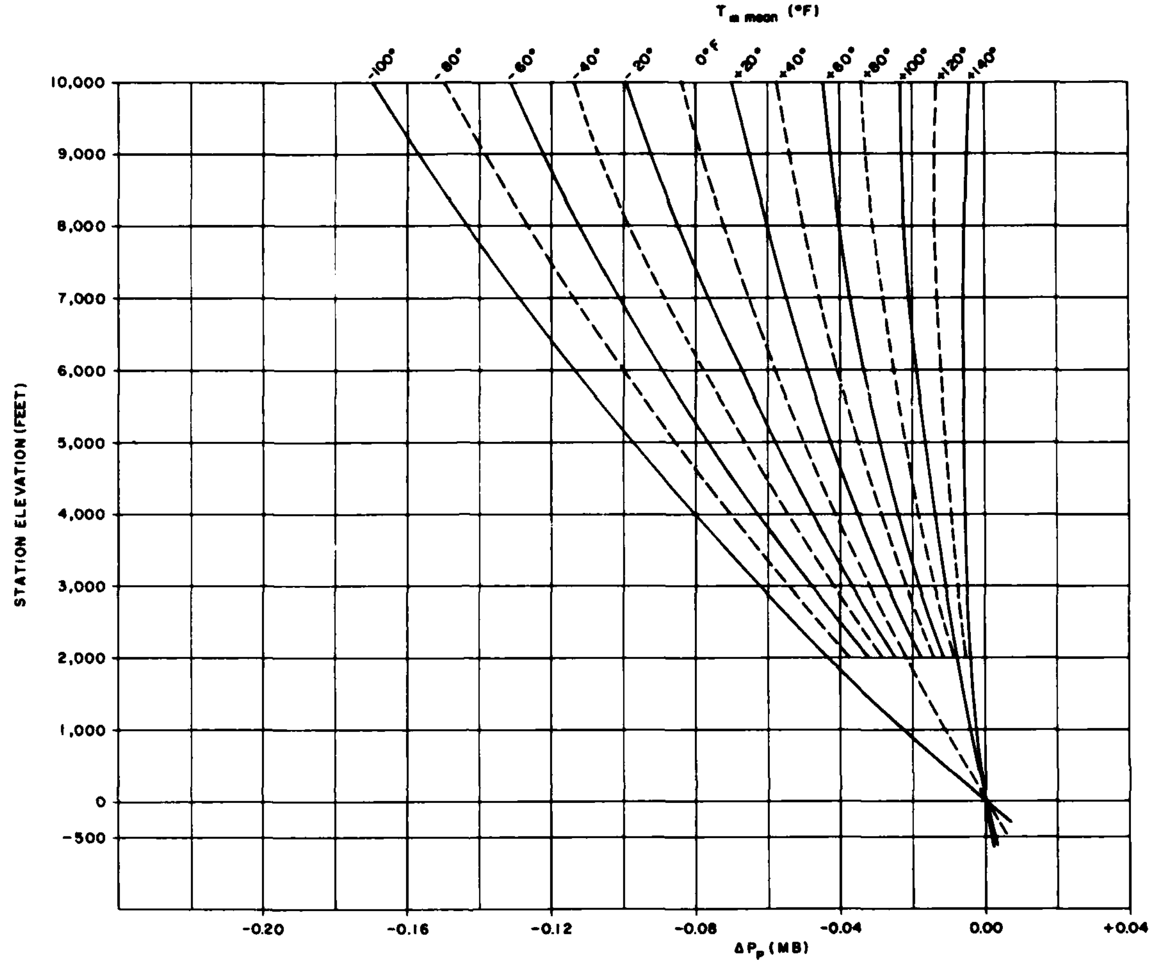

Figure 7. Nomogram for Determining ΔP_p, Which Is the Change in ΔP Produced by a 1-mb Increase in P_{SL}. The required input data are station elevation, and the adjusted mean temperature, $T_{m\ mean}$. Read ΔP_p to the nearest 0.01 mb.

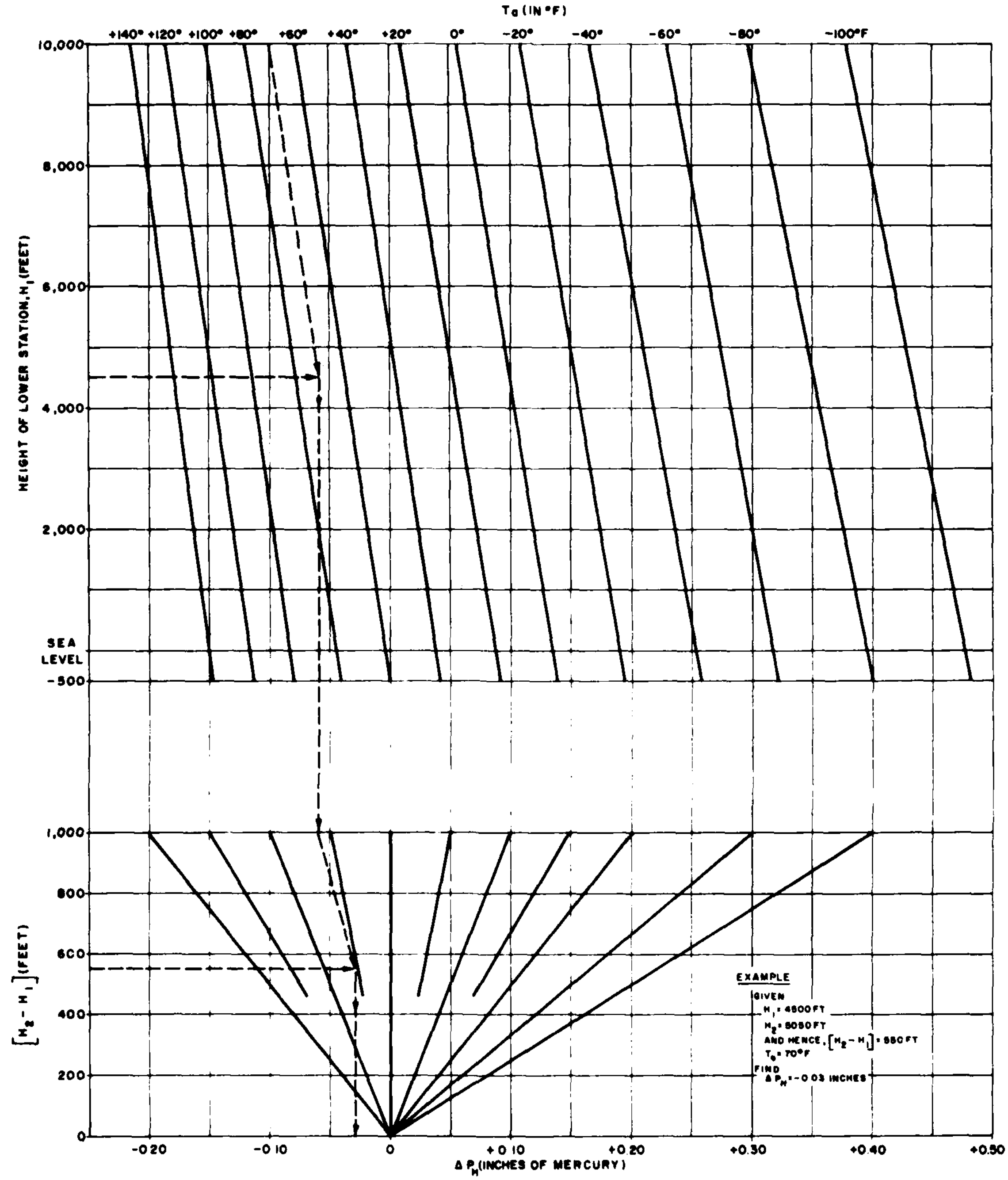

Figure 8. Nomogram for Determining ΔP_H, Which is the Difference in Altimeter Settings Due to Differences in Elevation and Temperature Between Two Stations. The required input data are the elevation of the lower station, H_1, the mean of the adjusted temperatures, T_a, and the difference between the elevations of the two stations (H_2 - H_1). Read $\triangle P_H$ to the nearest 0.02 inch. (Note that the vertical lines in the top portion and the slanting lines in the bottom portion of the nomogram do not have numerical values, but are used only as guidelines to apply the result from the top portion into the bottom portion.)

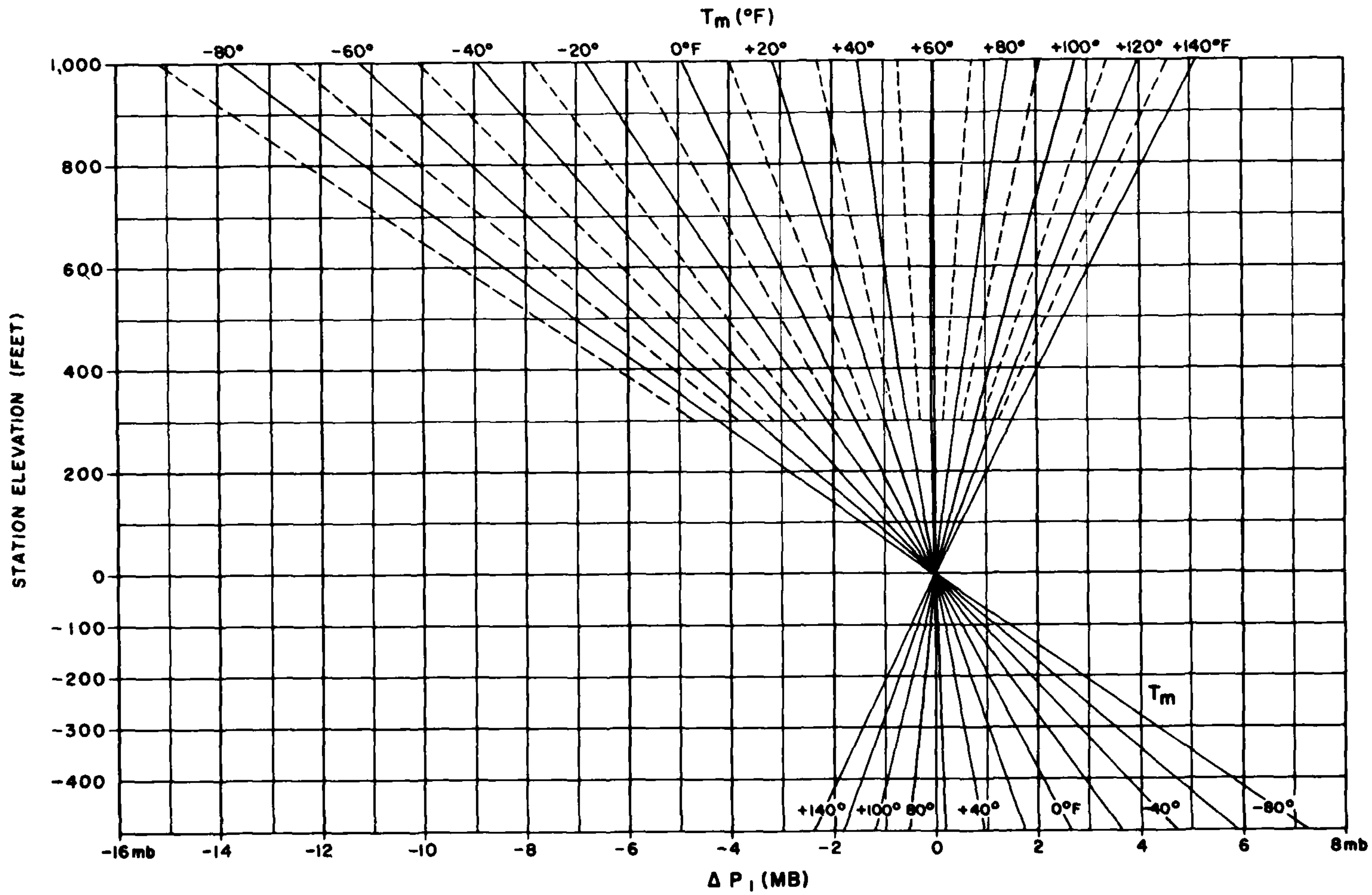

Figure 9. Nomogram for Determining ΔP_1 at Stations Whose Elevation is Less than 1000 Feet MSL. ΔP_1 is one component of ΔP, the difference between altimeter setting and sea-level pressure. The required input data are station elevation, and the adjusted 12-hour mean temperature, T_m. Read ΔP_1 to the nearest 0.5 mb.

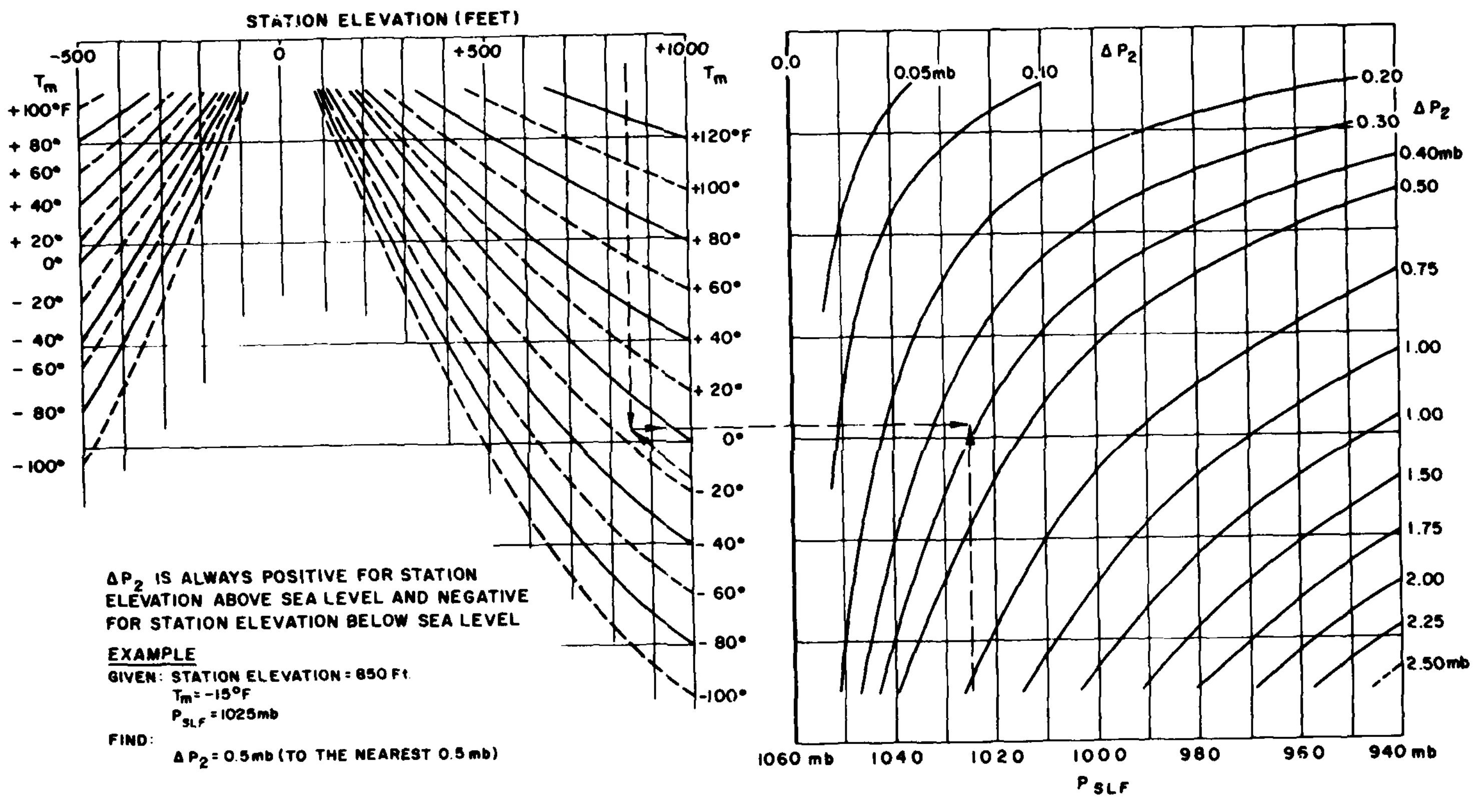

Figure 10. Nomogram for Determining ΔP_2 at Stations Whose Elevation is Less than 1000 Feet MSL. ΔP_2 is a component of ΔP, the difference between altimeter setting and sea-level pressure. The required input data are station elevation, the adjusted 12-hour mean temperature, T_m, and the forecast sea-level pressure, P_{SLF}. Read ΔP_2 to the nearest 0.5 mb.

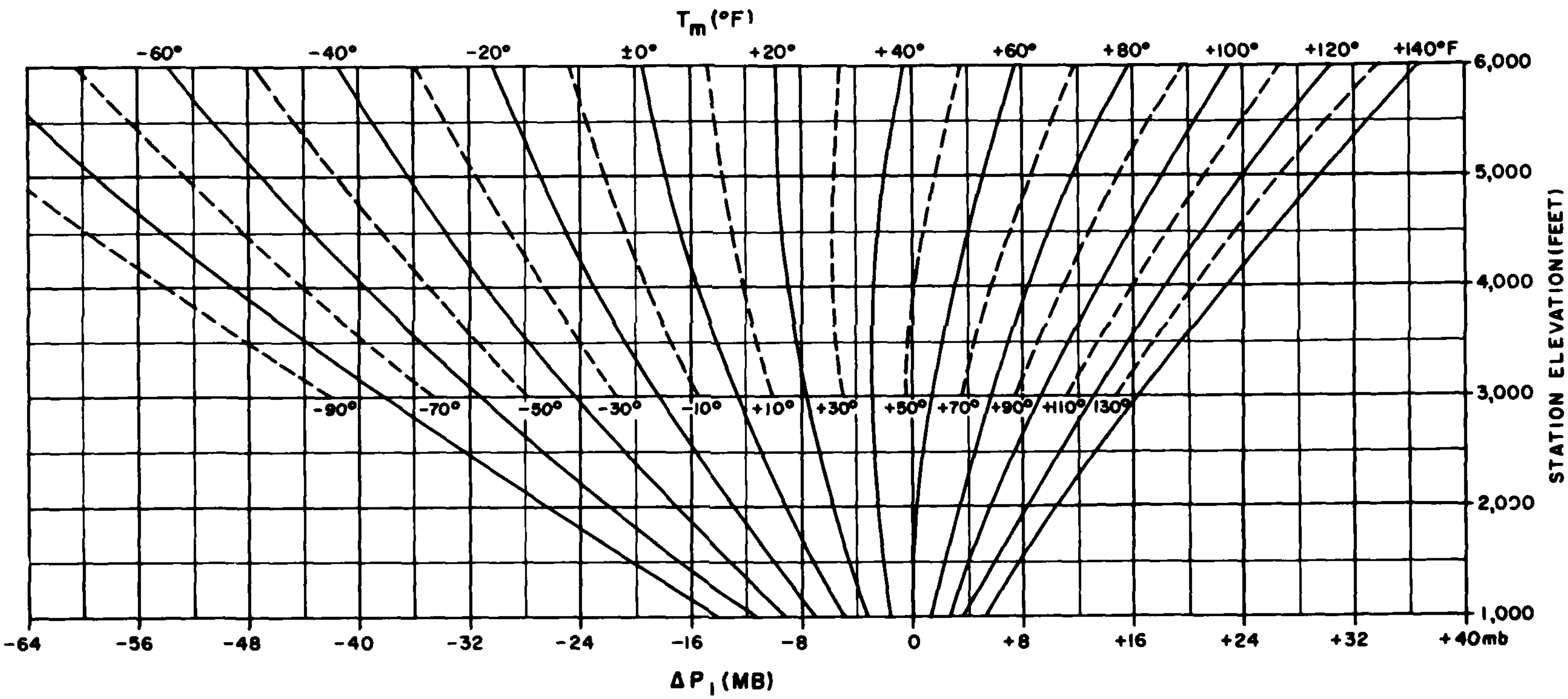

Figure 11. Nomogram for Determining ΔP_1 at Stations Whose Elevation is Between 1000 Feet and 6000 Feet MSL. ΔP_1 *is one component of* ΔP, *the difference between altimeter setting and sea-level pressure.* The required input data are station elevation, and the adjusted 12-hour-mean temperature, T_m. Read ΔP_1 to the nearest 0.5 mb.

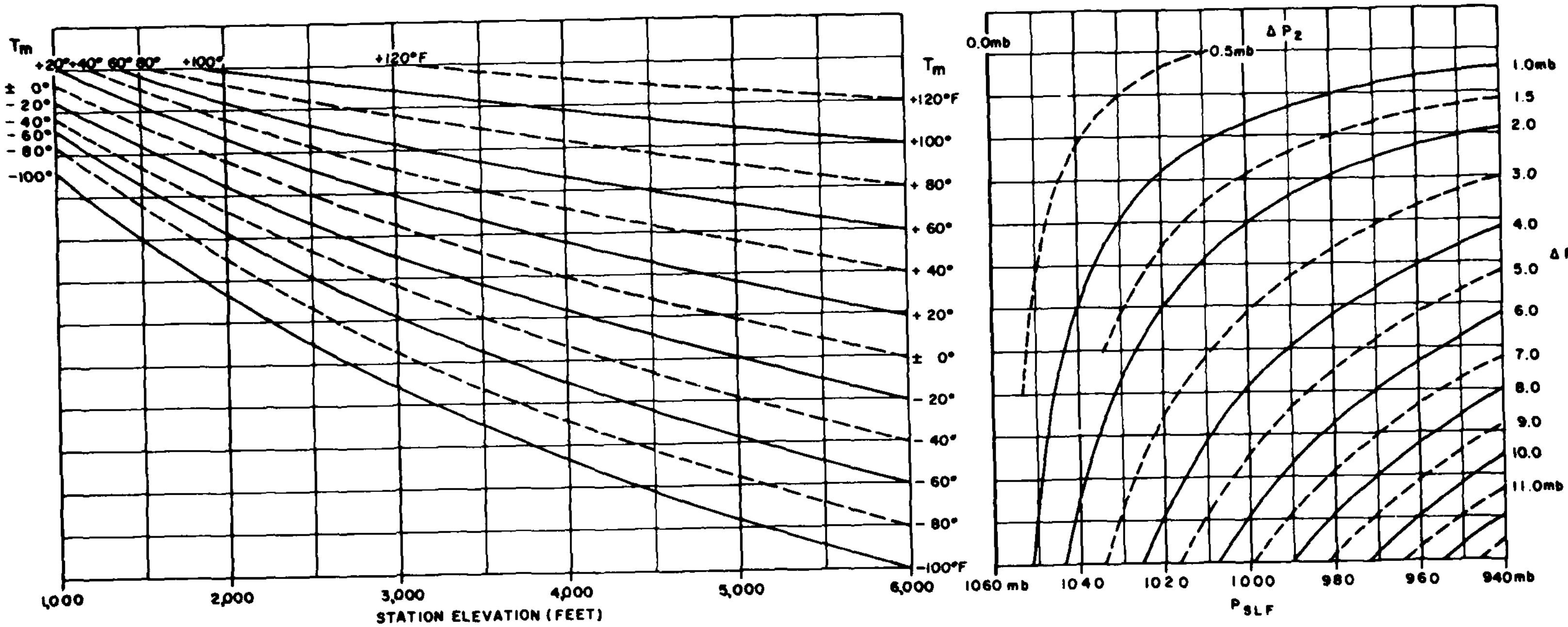

Figure 12. Nomogram for Determining ΔP_2 at Stations Whose Elevation is Between 1000 Feet and 6000 Feet MSL. ΔP_2 is a component of ΔP, the difference between altimeter setting and sea-level pressure. *The required input data are station elevation*, the adjusted 12-hour mean temperature, T_m, and the forecast sea-level pressure, P_{SLF}. Read ΔP_2 to the nearest 0.5 mb. (See Figure 10 for example of procedure.)

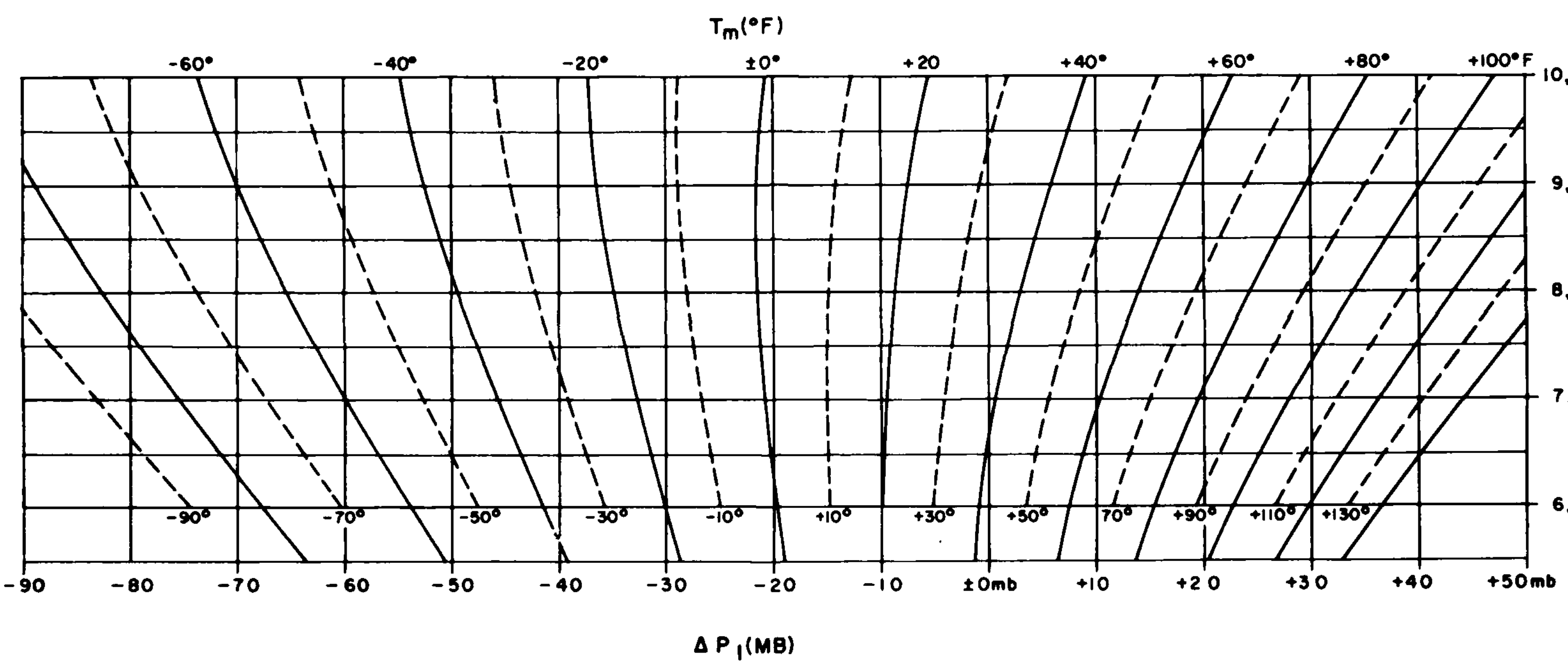

Figure 13. Nomogram for Determining ΔP_1 at Stations Whose Elevation is Between 6000 Feet and 10,000 Feet MSL. ΔP_1 is one component of ΔP, the difference between altimeter setting and sea-level pressure. The required input data are station elevation, and the adjusted 12-hour mean temperature, T_m. Read ΔP_1 to the nearest whole millibar from this nomogram, since the station is above 6000 feet.

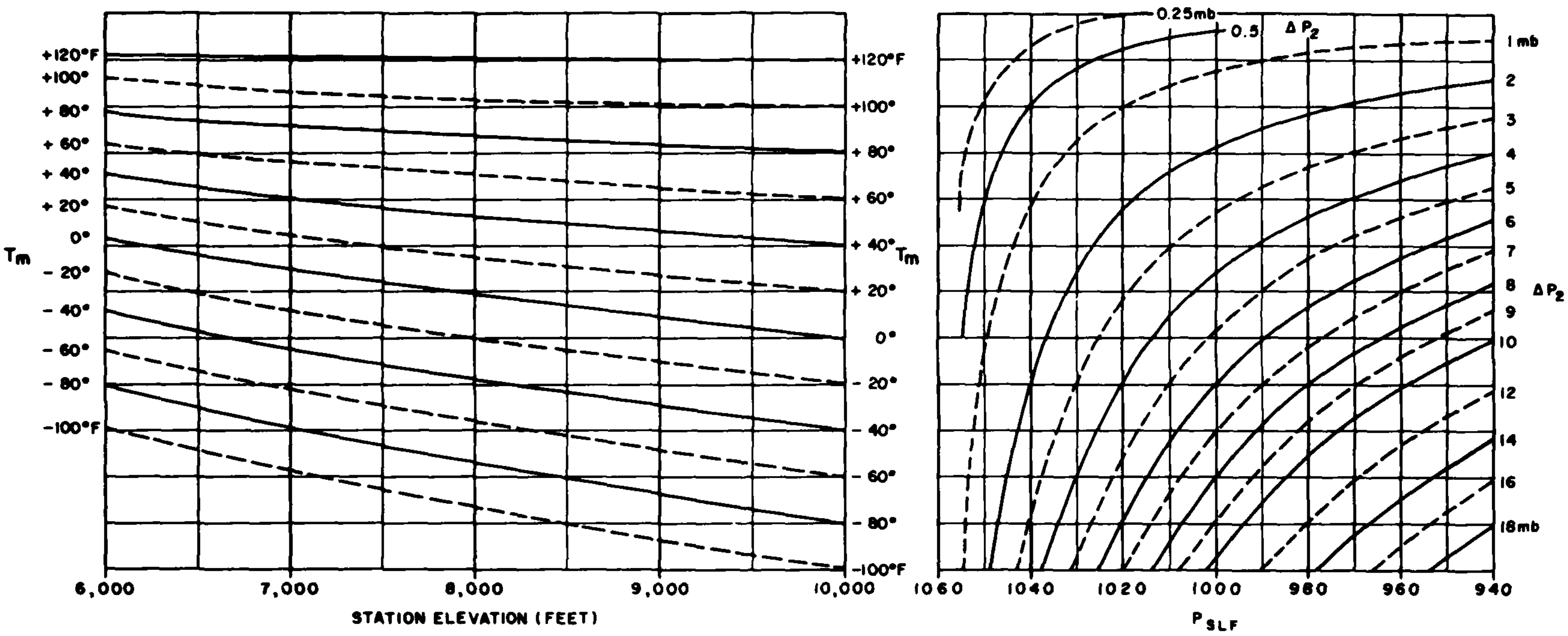

Figure 14. Nomogram for Determining ΔP_2 at Stations Whose Elevation is Between 6000 Feet and 10,000 Feet MSL. ΔP_2 is a component of ΔP, the difference between altimeter setting and sea-level pressure. The required input data are station elevation, the adjusted 12-hour-mean temperature, T_m, and the fore-cast sea-level pressure, P_{SLF}. Read ΔP_2 to the nearest whole millibar from this nomogram, since the station is above 6000 feet. (See Figure 10 for example of procedure.)

ANNUAL NORMAL STATION TEMPERATURE AND STATION ELEVATION

Some of these normal temperatures are for nearby observation points instead of for the station listed.

If U.S. stations not in this table are needed, find their elevations in the Enroute Supplement, USAF Flight Information Publication and interpolate their annual normal station temperatures from stations (of similar elevation) given here, or obtain them from climatic-data sources.

Station	Station Elev (ft)	T_{sn} (°F)
Alabama		
Birmingham	630	63
Brookley AFB	26	68
Craig AFB	207	65
Gairns AAF (Ft. Rucker)	303	66
Maxwell AFB	184	65
Alaska		
Annette Island	119*	46
Barrow	8	10
Big Delta	1266*	24
Eielson AFB	539	26
Elmendorf AFB	258	35
Galena Airport	125	26
Juneau	24	41
King Salmon	44	34
Ladd AFB	484	26
Nome	46	26
Tatalina AFS	939	23
Arizona		
Davis Monthan AFB	2654	68
Flagstaff	7018	45
Luke AFB	1093	70

*Field elevation

Station	Station Elev (ft)	T_{sn} (°F)
Arizona (Cont'd)		
Williams AFB	1382	70
Winslow	4880	55
Yuma (Yuma Co.)	206	75
Arkansas		
Blytheville AFB	253	61
Little Rock AFB	337	62
California		
Castle AFB	178	63
Edwards AFB	2316	66
George AFB	2876	66
Hamilton AFB	2	56
Los Angeles	104	61
March AFB	1530	66
Mather AFB	92	62
McClellan AFB	82	61
Norton AFB	1098	66
San Diego (Lindberg)	28	62
San Francisco	18	56
Travis AFB	72	60
Colorado		
Colorado Springs	6172*	49
Grand Junction	4839	52
Lowry AFB	5396	50
Connecticut		
Hartford (Bradley Field)	179	50
Delaware		
Dover AFB	38	55
District of Columbia		
Bolling AFB	28	57
Washington National Airport	65	57

*Field elevation

Station	Station Elev (ft)	T_{sn} (°F)
Flordia		
Eglin AFB	59	68
Homestead AFB	10	77
Jacksonville (Imeson)	119	69
MacDill AFB	12	72
McCoy AFB	105	73
Miami	12	76
Patrick AFB	25	73
Pensacola (Sherman NAS)	118	68
Tallahassee (Dale Mabry)	68	68
Tyndall AFB	22	68
Georgia		
Atlanta	976	62
Dobbins	1010	62
Hunter AFB	70	67
Lawson AAF (Ft. Benning)	241	65
Moody AFB	239	67
Robins AFB	277	66
Turner AFB	225	66
Hawaii		
Hickam AFB	13	76
Hilo (Gen. Lyman)	36	73
Idaho		
Boise	2858	51
Mountain Home AFB	2992	51
Pocatello	4478	47
Illinois		
Chanute AFB	749	51
Chicago (Midway)	623	50
Chicago (O'Hare Int'l)	667	50
Scott AFB	444	58
Springfield	613	52
Indiana		
Bakalar AFB	665	55
Bunker Hill AFB	804	50
Evansville (Dress Memorial)	388	57
Indianapolis	808	53

Station	Station Elev (ft)	T_{sn} (°F)
Iowa		
Des Moines	963	50
Sioux City	1103	49
Kansas		
Forbes AFB	1091	55
Marshall AAF (Ft. Riley)	1076	56
McConnell AFB	1388	57
Schilling AFB	1281	55
Kentucky		
Campbell AFB (Fort Campbell)	564	59
Godman AAF (Fort Knox)	735	56
Louisville (Standiford)	488	57
Louisiana		
Barksdale AFB	168	66
Chennault AFB	17	68
England AFB	89	67
Fort Polk AAF	333	67
New Orleans (Moisant)	30	69
Maine		
Dow AFB	162	42
Loring AFB	725	37
Presque Isle AFB	486	38
Portland	63	45
Maryland		
Andrews AFB	282	56
Baltimore (Friendship)	155	55
Massachusetts		
Bedford (Hanscom Field)	132	50
Boston (Logan)	29	51
Otis AFB	137	49
Westover AFB	247	49
Michigan		
Detroit	626	49
Kincheloe AFB	807	39
Sawyer AFB, K.I.	1190	40
Selfridge AFB	610	49
Wurtsmith AFB	618	44

Station	Station Elev (ft)	T_{sn} (°F)
Minnesota		
Duluth (W. Johnson)	1417	39
Minneapolis-St. Paul	838	46
Mississippi		
Greenville AFB	139	65
Keesler AFB	26	68
Missouri		
Richards-Gebaur AFB	1133	55
St. Louis (Lambert)	564	56
Springfield	1270	56
Whiteman AFB	838	55
Montana		
Billings	3570	47
Glasgow AFB	2760*	42
Kalispell	2973	43
Malmstrom AFB	3465	46
Nebraska		
Lincoln AFB	1169	52
North Platte (Lee Bird)	2787	50
Offutt AFB	1023	51
Nevada		
Ely (Yelland)	6262	45
Nellis AFB	1900	68
Stead AFB	5023	47
New Hampshire		
Grenier AFB	243	46
Pease AFB	88	47
New Jersey		
Atlantic City	76*	54
McGuire AFB	147	53
Newark	30	53

*Field elevation

Station	Station Elev (ft)	T_{sn} (°F)
New Mexico		
Cannon AFB	4301	57
Holloman AFB	4070	61
Kirtland AFB	5314	57
Walker AFB	3643	60
White Sands Proving Ground	4272	60
New York		
Griffiss AFB	476	49
Mitchel AFB	97	54
New York (La Guardia)	52	54
Niagara Falls Arpt.	596	48
Plattsburgh AFB	244	45
Stewart AFB	465	48
Suffolk Co. AFB	57	53
North Carolina		
Asheville	2253	56
Pope AFB (Ft. Bragg)	199	63
Seymour Johnson AFB	114	63
North Dakota		
Bismarck	1660	42
Fargo (Hector)	899	41
Minot	1667*	40
Ohio		
Cincinnati (Greater Cincinnati)	887	54
Cleveland (Cleveland-Hopkins)	805	51
Clinton Co. AFB	1054	52
Lockbourne AFB	744	52
Patterson AFB	822	53
Toledo	692	49
Wright AFB	805	53
Oklahoma		
Altus AFB	1375	60
Ardmore AFB	728	64
Fort Sill (Post Field)	1200	61
Tinker AFB	1355	60
Tulsa	674	61
Vance AFB	1290	59

*Field elevation

Stations	Stations Elev (ft)	T_{sn} (°F)
Oregon		
Burns	4162	47
Medford	1329	54
Pendleton	1495	53
Portland	39	53
Pennsylvania		
Olmstead AFB	306	53
Philadelphia	28	54
Pittsburgh (Greater Pittsburgh)	1225	51
Rhode Island		
Providence (Greene)	62	49
South Carolina		
Charleston AFB	59	67
Donaldson AFB	976	61
Shaw AFB	263	64
South Dakota		
Ellsworth AFB	3215	45
Huron	1289	46
Sioux Falls	1427	46
Tennessee		
Knoxville (McGhee-Tyson)	980	59
Nashville (Berry)	605	60
Memphis	284	62
Sewart AFB	522	60
Texas		
Amarillo AFB	3604	57
Bergstrom AFB	507	69
Biggs AFB	3923	63
Brooks AFB	598	70
Bryan AFB	275	69
Carswell AFB	617	66
Connally AFB	475	67
Corpus Christi (Cliff Maus)	44	71
Dallas (Love)	488	67
Dyess AFB	1777	64
Ellington AFB	39	70
Fort Worth (Amon Carter)	576	66
Foster AFB	116	71

Stations	Station Elev (ft)	T_{sn} (°F)
Texas (Cont'd)		
Goodfellow AFB	1878	66
Gray AFB	1021	67
Harlingen AFB	38	74
Kelly AFB	682	69
Laughlin AFB	1081	70
Perrin AFB	763	64
Randolph AFB	743	69
Reese AFB	3333	59
Sheppard AFB	1030	63
Webb AFB	2571	64
Utah		
Dugway Proving Grounds	4359	51
Hill AFB	4787	49
Salt Lake City (Airport #1)	4227	51
Vermont		
Burlington	340	45
Virginia		
Davison AAF (Ft. Belvoir)	67	56
Langley AFB	20	59
Norfolk	30	59
Richmond (Byrd)	164	58
Washington		
Fairchild AFB	2437	47
Larson AFB	1183	51
McChord AFB	50	52
Seattle (Boeing)	14	52
Seattle-Tacoma	450	51
Spokane (Geiger)	2365	47
West Virginia		
Huntington	565	57
Wisconsin		
Madison (Truax)	866	47
Milwaukee (Gen. Mitchell)	893	47
Wyoming		
Cheyenne	6144	45
Lander	5558	43
Sheridan	3968	44

1. General.

Sea-level pressure is not the same as altimeter setting because of differences in the way the two are computed from station pressure. They are similar only in that the standard-atmosphere lapse rate is assumed for both below station level.

2. Altimeter Setting:

a. Altimeter setting is computed by assuming that the standard atmosphere exists from the station down to sea level. Variations of altimeter setting from 29.921 inches of mercury or 1013.25 mb (the standard-atmosphere pressure at sea level) are assumed possible by allowing the standard atmosphere to be shifted vertically without other alterations. The equation relating height and pressure in the standard atmosphere below the tropopause is (from the WBAN Manual of Barometry, to be published):

$$\frac{P}{P_0} = \left(\frac{T_0 - ah}{T_0}\right)^n \qquad (1)$$

where:

P = pressure in millibars at a specific elevation,

P_0 = 1013.25 mb, standard pressure at sea level,

T_0 = 288.16°K, standard temperature at sea level,

a = 0.0065°C, standard lapse rate per geopotential meter in the troposphere,

h = vertical distance, in geopotential meters, from the point at which pressure is P to the point at which pressure is P_0,

n = 5.2561, a dimensionless constant.

b. Equation (1) can be modified fo: working down from station pressure to se: level as follows:

$$\frac{P}{P_{AS}} = \left[\frac{T_0 - ah}{T_0 + a(H-h)}\right]^n \qquad (\cdot)$$

where:

P = station pressure in millibars,

P_{AS} = altimeter setting in millibars,

H = station elevation in geopotential meters, and other symbols retain their previous meanings.

Solving (2) for P_{AS} gives:

$$P_{AS} = P\left[1 + \frac{aH}{T_0 - ah}\right]^n \qquad (3)$$

From (1)

$$ah = T_0 - T_0\left(\frac{P}{P_0}\right)^{1/n} \qquad (4)$$

Combining (3) and (4) gives

$$P_{AS} = P\left[1 + \frac{aH}{T_0\left(\frac{P}{P_0}\right)^{1/n}}\right]^n \qquad (5)$$

Equation (5) may be used to compute the altimeter setting at a particular station when its elevation and station pressure are known. This equation neglects any difference between weather-station elevation and runway elevation and therefore is not strictly accurate. However, this will rarely cause an error as great as 0.01 inch of mercury, and is accurate enough for the present purpose. (This equation also neglects the plateau correction, and other arbitrary corrections.)

3. Sea-Level Pressure:

a. Sea-level pressure is obtained from station pressure by the following equation (from advanced drafts of the forthcoming WBAN Manual of Barometry):

$$P_{SL} = P \cdot 10^{KH/T_{mv}} \tag{6}$$

where

P_{SL} = sea-level pressure in millibars,

P = station pressure in millibars,

K = 0.0266895°R/gpm (gpm = geopotential meters),

H = station elevation in gpm,

$$T_{mv} = 459.688 + T_s + 0.0117 \frac{H}{2} + e_s C_h + F, \tag{7}$$

where

T_s = mean of current station temperature and station temperature 12 hours ago, in °F,

0.0117 = standard-atmosphere tropospheric lapse rate in °F/gpm,

e_s = current station vapor pressure in millibars,

C_h = correction factor from WBAN Manual of Barometry,

F = plateau correction and correction for local lapse-rate anomaly from the WBAN Manual of Barometry. Note that the use of the term F is not standardized outside of the United States and Alaska.

4. Difference Between Altimeter Setting and Sea-Level Pressure:

a. Equations (5) and (6) may be combined to give

$$\Delta P = P_{AS} - P_{SL} = P\left[1 + \frac{aH}{T_o\left(\frac{P}{P_o}\right)^{1/n}}\right]^n - P \cdot 10^{KH/T_{mv}} \tag{8}$$

Since it is assumed that sea-level pressure, and not station pressure, is known, Equation (6) is solved for P and this is substituted in (8), giving:

$$\Delta P = P_{SL} \cdot 10^{-KH/T_{mv}}\left[1 + \frac{aH}{T_o\left(\frac{P_{SL} \cdot 10^{-KH/T_{mv}}}{P_o}\right)^{1/n}}\right]^n - P_{SL}$$

or

$$\Delta P = P_{SL}\left[1 + \frac{aH \cdot 10^{KH/nT_{mv}}}{T_o\left(\frac{P_{SL}}{P_o}\right)^{1/n}}\right]^n \div 10^{KH/T_{mv}} - P_{SL} \tag{9}$$

b. There are some minor inaccuracies in Equation (9) but they may be safely neglected when we are dealing with forecast altimeter setting:

(1) Meteorologists and engineers do not use the same definition of geopotential meter. Therefore, the H for altimeter setting and the H for sea-level pressure are actually slight! · different. The ratio of the standard geopotential meter to the meteorological geopotential meter is 9.80665/9.80000. The difference between the two is less than one part per thousand.

(2) The formula neglects the difference between station elevation and runway elevation. However, this will very rarely introduce an error as great as 0.01 inch of mercury if the elevation difference is less than 50 feet. If desired, the error may be computed by use of Figure 8.

(3) The WBAN Manual of Barometry will give n to only five significant figures. This may occasionally cause an error of 0.01 mb.

(4) The biggest inaccuracy is not in the equation itself but in determining the correct values of moisture correction and plateau correction, which enter into T_{mv}. This error may be as much as 5°F (in Figures 2, 3, and 4) and causes the same size error in T_m, which is used as a parameter in all the methods given for arriving at forecasts of altimeter setting.

DAT

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